DAVE THUMSEN

Technical Specification
For Replacement Digital Static Excitation System

Intermountain Power Project
Delta, Utah

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2. DIGITAL STATIC EXCITATION SYSTEM REQUIREMENTS

Each excitation system shall be of the potential source rectifier type, and shall meet the requirements for a high initial response excitation system per IEEE Standard 421-1972. The system shall include an excitation power transformer, power converter assembly, voltage regulating logic, limiting and protective devices, and functional controls as specified herein.

2.1 STANDARDS AND ENVIRONMENTAL LIMITS

The excitation control system shall be designed, manufactured and assembled in accordance with the following standards:

2.1.1 SUPPORTED STANDARDS

ANSI/IEEE Standards

421.1	Standard Definitions for Excitation Systems for Synchronous Machines
421.2	Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems
421.3	High-Potential Test Requirements for Excitation Systems for Synchronous Machines
421.4	Guide for the preparation of Excitation Systems Specifications
421.5	Recommended Practice for Excitation Systems for Power Stability Studies
C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers including those with Solid Cast and/or Resin-Encapsulated Windings
C57.110	Recommended Practice for Establishing Transformer Capability when Supplying Non-Sinusoidal Load Currents
C57.116	IEEE Guide for Transformers Directly Connected to Generators
C37.90.1	Surge Withstand Capability (SWC) tests for Protective Relays and Relay Systems
C57.18.10	Practices and Requirements for Semiconductor Power Rectifier Transformers

Other Standards

UL 508C	Safety Standard Industrial Control Equipment
CSA 22.2 No. 14	Industrial Control Equipment
UL 796	Printed Circuit Boards
EN 50178	Electronic Equipment for use in Power Installations
IEC EN 55011	Industrial equipment emissions
IEC EN 61000-4	Industrial equipment immunity
UBC	Seismic Code section 2312 Zone 4
NFPA70	NEC (National Electric Code)

2.2 STATIC EXCITATION SYSTEM HARDWARE

2.2.1 ENCLOSURE

The enclosure lineup shall be supplied in a NEMA 1 / IP20 freestanding, indoor-type metal cabinet for floor mounting installation. The lineup may consist of several cabinets bolted together. The standard equipment shall be designed to minimize the installation effort. The equipment shall be designed to operate in an ambient temperature range of 0° C to 50°C and an altitude of 4700 feet or less.

Each cabinet shall be of a rigid, self-supporting, enclosed panel with a full-length door to provide easy access to the equipment. Each door shall be equipped with a suitable handle, three-point latch, and provisions for locking. Power bridge doors and power auxiliary cabinets shall be bolted closed to comply with plant safety guidelines. The cabinet color shall be ANSI-70 (light gray) on exterior surfaces.

Strip heaters shall be provided to keep the temperature inside the enclosure at least 5°C higher than the ambient temperature in order to prevent condensation. The heaters shall be energized from a 120 VAC source provided by the purchaser. The heaters shall be rated for 240 VAC to maximize availability. Both front and rear door access is acceptable.

For this project door-activated light switches and a 120V duplex receptacle shall be provided in the control section of the enclosure.

2.2.2 DIMENSIONS

The contractor shall supply dimension and weight information of the equipment.

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2.2.5 BRIDGE COOLING FANS

Each power bridge shall contain (1) drawer mounted cooling fan supplied from an external single-phase 115 VAC power source. In the event the fan malfunctions, the specific power bridge will shutdown, and the redundant bridge shall assume the additional load current necessary for the field without reduction of unit MWATT or MVAR load. Provisions shall be made such that the malfunctioning fan can then be repaired and the power bridge can be returned to service without exposing plant personnel to high voltage bridge components.

ADVANTAGE ?
DISADVANTAGE ?

2.2.6 INCOMING AC ISOLATION DEVICE

This project will not require an incoming AC isolation device. The excitation transformer secondary shall be connected directly to the excitation system power bridge. MECHNICAL ISOLATION

2.2.7 DC FIELD INTERRUPTING DEVICE

(1) single pole DC field breaker shall be provided to interrupt positive leg bridge output. The DC field breaker shall be installed within the exciter enclosure and shall not require a separate cubicle or additional bus work as part of the site installation.

2.2.8 POWER SUPPLY MODULE

Each of the control sections shall be powered from independent power supply modules. The independent design shall minimize the effect of a failed power supply on operation of the unit. A failed power supply shall not cause the unit to trip.

2.2.9 POWER DISTRIBUTION MODULE

Control power shall be acquired from an external 125 VDC source and one or two external 115 VAC sources. Outputs from the power distribution module shall be fused, with pass through switches, and have LED status indicators.

2.2.10 PT AND CT ISOLATION SWITCHES

Signal isolating knife switches shall be provided to isolate the PT and CT feedback signals from the voltage regulator. The CT isolation switch shall be of the shorting type to prevent inadvertently opening the CT circuit when the switch is open. CT sensing will be 5A . PT sensing will be 120 VAC.

2.2.11 INCOMING AC LINE-TO-LINE FILTERS

Fuse protected line-to-line series RC filter circuits shall be provided to dampen voltage spikes associated with bridge operation to minimize the voltage distortion at the excitation transformer secondary.

2.2.12 SHAFT VOLTAGE SUPPRESSION

A generator shaft voltage suppressor shall be provided to limit shaft voltage to ground caused by thyristor commutation.

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2.2.17 MISCELLANEOUS HARDWARE FEATURES

2.2.17.1 86EX LOCKOUT RELAY

An 86 Lockout Relay shall be mounted in the excitation system enclosure. This relay shall serve as a manual operator interface to indicate an excitation system trip. This relay shall operate when the exciter trip output is activated.

2.2.17.2 EXCITATION TRANSFORMER PROTECTION RELAY

A digital transformer protection relay shall be provided. This relay shall contain overcurrent primary protection, overcurrent secondary protection and differential protection.

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2.3.1.6 GENERATOR FIELD TEMPERATURE CALCULATION

This function shall calculate the generator field resistance by dividing the generator field voltage by the generator field current. From the known field resistance at 25°C and the linear resistance temperature change in copper, the algorithm shall calculate operating temperature. An adjustable high temperature alarm output contact shall also be included.

2.3.1.7 OPERATOR CONTROL SIMULATOR

A detailed generator model shall be included as part of the software. It shall be configured to closely match the operation of the actual generator, including combined turbine/generator inertia. This feature shall be used for operator training, and shall support the checkout of regulators, limiters, and protection functions while the unit is shut down.

2.3.1.8 POWER SYSTEM STABILIZER

This function shall provide an additional input to the automatic regulator to improve power system dynamic performance. The PSS function shall be represented by a recently published IEEE PSS2A or PSS2B model. Provision for a switchable washout filter, used to modify the PSS control during transient frequency excursions, shall be standard. The benefit of the switchable washout filter is to limit generate voltage excursions due to power/load imbalances.

2.3.2 LIMITER FUNCTIONS

2.3.2.1 VOLTS PER HERTZ LIMITER

This function shall act to maintain generator volts/hertz ratio, 110% shall be standard. The V/Hz Limiter setpoint shall be programmable.

2.3.2.2 GENERATOR FIELD CURRENT ON-LINE OVER EXCITATION LIMITER

The over excitation limit function shall be designed to use the generator field winding short-time thermal requirements as defined by IEEE C50.13.

2.3.2.3 GENERATOR FIELD CURRENT OFF-LINE OVER EXCITATION LIMITER

This limit shall maintain excitation of the machine below an acceptable level when the generator is in manual mode. Off-line over excitation limit shall be 120% AFNL as standard.

2.3.2.4 UNDER EXCITATION LIMITER

This function shall prevent the AC regulator from reducing excitation to a level that would result in loss of synchronism. This limit shall allow the generator to provide all kilowatt loadings and its under-excited reactive output capability, within the generator steady-state stability limits.

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2.3.4 PROTECTION FUNCTIONS

The following functions shall be provided.

- V/HZ Straight Time and Inverse Time
- Generator Over Voltage Straight Time
- Loss of Excitation
- Generator Field Current Over Excitation Offline and Online
- Instantaneous Bridge Over Current
- PPT Phase Unbalance
- De-Excitation SCR Failure

2.4 OPERATOR CONTROL INTERFACES

2.4.1 LOCAL DIAGNOSTIC INTERFACE KEYPAD

Local control and indication shall be accomplished via a compact, multi-function, operator keypad mounted on the excitation cabinet door to provide local control and diagnostic functions. Start/stop commands, regulator transfer commands, and regulator selection can be issued from the keypad. The keypad shall also include meter displays indicating system conditions, such as generator MW and Mvars, field current and voltage, and regulator balance. Diagnostic displays such as the alarm history, setup, application data, and I/O interface displays shall provide system information for service personnel.

2.4.2 REMOTE OPERATOR INTERFACE

A touch screen flat panel display for use as an operator interface station shall be provided. The operator interface shall provide standard system monitoring, enunciation and control screens and functions. The operator interface shall be manufactured to accommodate remote mounting in the control room.

2.5 COMMUNICATION INTERFACES

2.5.1 DCS INTERFACE (ETHERNET MODBUS)

The excitation system shall support an Ethernet 10baseT hardware interface that utilizes a Modbus protocol. Both commands and data shall be supported.

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2.7 TESTING

2.7.1 STANDARD FACTORY TEST

Standard factory testing shall include production inspection, performed immediately prior to shipment. This inspection shall verify the mechanical integrity, conformance to special owner hardware requirements, appearance, and design completeness of the enclosure. The owner, or its representative, may elect to participate in this inspection at no charge. The owner anticipates this inspection to last approximately two hours, and shall include the following:

- Inspection of appearance and mechanical integrity
- Review for completion
- Review of test instructions
- Review of test logs
- Review of test defect record
- Check engineering log
- Shortages
- Audit of labeling nomenclature
- Review of As-shipped prints

In addition, the owner shall have a review meeting with the responsible engineer. The owner shall review all paperwork relevant to the engineering and testing of the requisition. This shall include the elementary, I/O list, alarm list, layouts, outlines, test sign-off sheets, and such. This documentation shall provide the basis for certification that the owner's hardware and software went through the proper engineering, verification, and test processes. The owner expects the duration of this witness point to be approximately two hours.

The contractor shall inform the owner two weeks prior to the inspection date so that the customer can make travel arrangements.

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3. ASSOCIATED EQUIPMENT

3.1 POWER POTENTIAL TRANSFORMER (PPT)

Transformer construction techniques and paint process shall be manufacturer's standard.

To maintain the design philosophy of the plant the owner is requiring single phase excitation transformers to be connected to the generator output. This arrangement of transformers is required to minimize the possibility of a single-phase line to ground fault escalating into a three-phase bolted fault. Bus work required to connect the single phase transformers shall be included. Configuration of transformers shall allow for replacement of a single-phase unit. The transformer shall, at a minimum, adhere to the following specification.

Transformer Type:	3 Single Phase Cast Coil
Enclosure:	NEMA1 (Indoor Ventilated)
Total KVA:	10270
Phases:	Three (3)
Frequency:	60
Conductor:	Copper
Primary/Secondary Winding BIL:	125 KV/ 20 KV
Primary/Secondary Voltage:	26 ~~24000~~/1150 VAC
Cooling	AA Self Cooled
Temperature Rise:	100C
Ambient Temperature:	40C Avg./50C Max.
Impedance:	6% Nominal
Insulation:	H185°C
Overload:	150% for 30 seconds
Primary Termination:	Isolated Phase Bus
Secondary Termination:	Isolated Phase Bus
Primary CT's:	1 per phase, C200
Secondary CT's:	1 per phase, C200
Primary Connection Box:	None
Secondary Connection Box:	None
Testing:	ANSI/IEEE C57 Transformer Standards
Duty	Exciter Duty/Non linear load

3.1.1 PPT TEST

PPT testing shall be manufacturer's standard. All tests shall be made in accordance with the latest revision of ANSI standard Test code C57.12.90, where applicable.

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3.4 EXCITER TRANSFORMER SECONDARY BUS

The exciter transformer secondary bus shall be isolated phase (3) conductor. The conductor shall be aluminum with an aluminum enclosure. This bus shall connect the secondary of the exciter transformer to the exciter power bridges. The bus shall be manufactured in sections to allow for shipment. The AC bus shall have the following ratings:

Continuous Voltage -	1.2 KV
BIL -	30 KV
Continuous Current -	6000 ADC
Conductor -	Aluminum

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4.2.3 EXCITATION SYSTEM INSTALLATION DESIGN PACKAGE

An Installation & Construction Design Engineering package shall be provided. This package shall provide documentation support for both the new equipment as well as the engineering documentation of the construction details for the installation of this new equipment. Engineering and documentation shall include the following:

The following support functions shall be included in the installation and construction design engineering package:

- Participation in a project kick-off meeting
- Detailed engineering review of the existing excitation system in coordination with the planned new equipment
- Review PT's & CT's for quantity, ratio & system location
- Review existing & new PPT for ratings, location & environment
- Advise Functions Removed with old Equipment and Functionality being added with new Equipment.
- Discuss Protective & Limiting Functions, Sequence of Operation, and Annunciation of the new excitation system.
- Advise Requirements of new Equipment for AC, DC, Preferred Power and Field Flashing if applicable
- Identify Equipment needs for Generator breaker contacts "52" and "86" lockouts. Review Control and Trip Scheme requirements
- Review Operator Station and Switches, Meters to be removed or retained, their disposition and closure of openings
- Review new Equipment Anchoring and Grounding requirements

Engineering required too mark up (red-line) the following owner drawings shall be included:

- Plant General Arrangement for Removal of Old Equipment
- Demolition mark-ups of old Equipment Cabinetry, Interconnection Wiring, and Control Bench Instrumentation
- Primary System One-line Drawings
- Excitation System Three-Line Diagrams
- Existing Conduit & Tray Installation Details
- Provide Marked-up Grounding Detail Drawings

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Removal of the existing Generrex exciter power bridges located on the machine lagging.

Installation of the DC bus between the new excitation system and the collector enclosure.

Final connection of control and power cable.

Final connection of the excitation transformer primary bus to the existing generator output isophase bus.

Work hours are defined as follows:

Straight-time shall consist of eight (8) hour work days Monday through Friday, 8 AM to 5 PM exclusive of GE holidays

Overtime shall consist of any hours on a daily basis in excess of eight (8) hours worked or Saturdays, excluding Sunday.

Double time shall consist of hours worked on Sunday or contractor holidays.

4.3.1 DIRECT SUPERVISION OF CONTRACT LABOR

The contractor shall provide Field Engineering Service for direct supervision of contractor supplied craft labor.

4.3.2 EXCITATION SYSTEM COMMISSIONING

The contractor shall provide Field Engineering Service for commissioning of the new excitation system. Commissioning shall include Pre-start Checks, Offline Checks and Online Checks.

4.3.3 PSS COMMISSIONING

The contractor shall provide Field Engineering Service for commissioning of the PSS function. The PSS function shall be verified once the unit is near rated load.

4.3.4 IEEE MODEL VERIFICATION

The contractor shall provide Field Engineering Service for model verification testing.

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